

**CLAIMS:**

1. A process for selectively removing large catalyst particles from a reaction system, wherein the reaction system comprises a reaction zone, a disengaging zone, optionally a catalyst regenerator, optionally a catalyst cooler and optionally a catalyst stripper, the process comprising the steps of:
  - (a) feeding a plurality of catalyst particles into the reaction zone;
  - (b) contacting the plurality of catalyst particles with a feedstock in the reaction zone under conditions effective to convert at least a portion of the feedstock to product;
  - (c) directing a portion of the plurality of catalyst particles from the reaction system to a separation unit, wherein the portion of the plurality of catalyst particles has a first median particle diameter;
  - (d) separating the portion of the plurality of catalyst particles in the separation unit into a small catalyst stream and a large catalyst stream, wherein the small catalyst stream has a second median particle diameter less than the first median particle diameter; and
  - (e) directing at least a portion of the small catalyst stream to the reaction system.
2. The process of claim 1, wherein the large catalyst stream has a third median particle diameter greater than the first median particle diameter.
3. The process of claim 2, wherein the feedstock comprises an oxygenate and the product comprises light olefins.
4. The process of claim 3, wherein the third median particle diameter is at least about 100 microns.
5. The process of claim 4, wherein the third median particle diameter is at least about 120 microns.

6. The process of claim 5, wherein the third median particle diameter is at least about 150 microns.
7. The process of claim 4, wherein the second median particle diameter is less than 100 microns.
8. The process of claim 7, wherein the second median particle diameter is no greater than about 80 microns.
9. The process of claim 3, wherein the second median particle diameter is less than about 120 microns.
10. The process of claim 9, wherein the second median particle diameter is no greater than about 100 microns.
11. The process of claim 10, wherein the second median particle diameter is no greater than about 80 microns.
12. The process of claim 3, wherein the first median particle diameter is from about 60 to about 120 microns.
13. The process of claim 12, wherein the first median particle diameter is from about 65 to about 100 microns.
14. The process of claim 13, wherein the first median particle diameter is from about 65 to about 85 microns.
15. The process of claim 3, wherein the plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41,

SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.

16. The process of claim 3, wherein the separation unit is selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
17. The process of claim 16, wherein the separation unit comprises a counter-flow cyclone separator.
18. The process of claim 17, wherein the counter-flow cyclone separator is tunable.
19. The process of claim 3, wherein step (d) comprises contacting the portion of the plurality of catalyst particles with a turbulizing stream under conditions effective to form the small catalyst stream and the large catalyst stream.
20. The process of claim 3, wherein step (b) forms an at least partially deactivated catalyst, the process further comprising the step of:  
(f) regenerating the at least partially deactivated catalyst in the catalyst regenerator to form the portion of the plurality of catalyst particles, wherein step (c) comprises directing the portion of the plurality of catalyst particles from the catalyst regenerator to the separation unit.
21. The process of claim 3, wherein step (b) forms an at least partially deactivated catalyst, the process further comprising the step of:  
(f) stripping the at least partially deactivated catalyst in the catalyst stripper to form the portion of the plurality of catalyst particles, wherein step (c) comprises directing the portion of the plurality of catalyst particles from the catalyst stripper to the separation unit.

22. The process of claim 3, wherein the process further comprises the step of:
- (f) cooling a heated catalyst particle from the reaction system in the catalyst cooler, wherein step (c) comprises directing the portion of the plurality of catalyst particles from the catalyst cooler to the separation unit.
23. A process for selectively removing large catalyst particles from a reaction system, wherein the reaction system comprises a reaction zone, a disengaging zone, optionally a catalyst regenerator, optionally a catalyst cooler and optionally a catalyst stripper, the process comprising the steps of:
- (a) feeding a plurality of catalyst particles into the reaction zone;
  - (b) contacting the plurality of catalyst particles with a feedstock in the reaction zone under conditions effective to convert at least a portion of the feedstock to product, wherein the plurality of catalyst particles comprises catalyst fines and catalyst non-fines;
  - (c) directing the product and the plurality of catalyst particles to the disengaging zone;
  - (d) yielding an effluent stream from the disengaging zone, wherein the effluent stream comprises at least a majority of the product and at least a portion of the catalyst fines;
  - (e) directing at least a majority of the catalyst non-fines from the disengaging zone to the reaction zone;
  - (f) directing a portion of the plurality of catalyst particles from the reaction system to a separation zone, wherein the portion has a first median particle diameter;
  - (g) separating the portion in the separation zone into a small catalyst stream and a large catalyst stream, wherein the small catalyst stream has a second median particle diameter less than the first median particle diameter; and
  - (h) directing at least a portion of the small catalyst stream to the reaction system.

24. The process of claim 23, wherein the large catalyst stream has a third median particle diameter greater than the first median particle diameter.
25. The process of claim 24, wherein the feedstock comprises an oxygenate and the product comprises light olefins.
26. The process of claim 25, wherein the third median particle diameter is at least about 100 microns.
27. The process of claim 26, wherein the third median particle diameter is at least about 120 microns.
28. The process of claim 27, wherein the third median particle diameter is at least about 150 microns.
29. The process of claim 26, wherein the second median particle diameter is less than about 100 microns.
30. The process of claim 29, wherein the second median particle diameter is no greater than about 80 microns.
31. The process of claim 25, wherein the second median particle diameter is less than about 120 microns.
32. The process of claim 31, wherein the second median particle diameter is no greater than about 100 microns.
33. The process of claim 32, wherein the second median particle diameter is no greater than about 80 microns.
34. The process of claim 25, wherein the first median particle diameter is from about 60 to about 120 microns.

35. The process of claim 34, wherein the first median particle diameter is from about 65 to about 100 microns.
36. The process of claim 35, wherein the first median particle diameter is from about 65 to about 85 microns.
37. The process of claim 25, wherein the plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.
38. The process of claim 25, wherein the separation zone is disposed within a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
39. The process of claim 38, wherein the separation unit comprises a counter-flow cyclone separator.
40. The process of claim 39, wherein the counter-flow cyclone separator is tunable.
41. The process of claim 25, wherein step (g) comprises contacting the portion of the plurality of catalyst particles with a turbulizing stream under conditions effective to form the small catalyst stream and the large catalyst stream.
42. The process of claim 25, wherein step (f) comprises directing the portion of the plurality of catalyst particles from the reaction zone to the separation zone.

43. The process of claim 25, wherein step (f) comprises directing the portion of the plurality of catalyst particles from the disengaging zone to the separation zone.
44. The process of claim 25, wherein step (h) comprises directing the at least a portion of the small catalyst stream to the disengaging zone.
45. The process of claim 25, wherein step (h) comprises directing the at least a portion of the small catalyst stream to the reaction zone.
46. A process for selectively removing large catalyst particles from a reaction system, wherein the process comprises the steps of:
  - (a) providing a first plurality of catalyst particles in a reaction zone, wherein the first plurality of catalyst particles has a first median particle diameter, and wherein the first plurality of catalyst particles comprises catalyst fines;
  - (b) contacting the first plurality of catalyst particles with a feedstock in the reaction zone under conditions effective to convert at least a portion of the feedstock to product;
  - (c) directing the first plurality of catalyst particles from the reaction zone to a disengaging zone;
  - (d) removing a portion of the catalyst fines from the disengaging zone under conditions effective to form a second plurality of catalyst particles in the disengaging zone, wherein the second plurality of catalyst particles has a second median particle diameter greater than the first median particle diameter;
  - (e) directing a portion of the second plurality of catalyst particles from the reaction zone or the disengaging zone to a separation zone;
  - (f) separating the portion of the second plurality of catalyst particles into a small catalyst stream and a large catalyst stream, wherein the small

catalyst stream has a third median particle diameter less than the second median particle diameter; and

(g) directing at least a portion of the small catalyst stream to the reaction system.

47. The process of claim 46, wherein the large catalyst stream has a fourth median particle diameter greater than the second median particle diameter
48. The process of claim 47, wherein the feedstock comprises an oxygenate and the product comprises light olefins.
49. The process of claim 48, wherein the process further comprises the step of:  
(h) monitoring the second median particle diameter.
50. The process of claim 49, wherein step (e) is responsive to a determination in step (h) that the second median particle diameter has exceeded a predetermined limit.
51. The process of claim 50, wherein the predetermined limit is greater than about 120 microns.
52. The process of claim 50, wherein the predetermined limit is between about 100 microns and about 120 microns.
53. The process of claim 50, wherein the predetermined limit is between about 90 microns and about 100 microns.
54. The process of claim 49, wherein the monitoring in step (h) occurs offline.
55. The process of claim 49, wherein the monitoring is performed by a laser scattering particle size analyzer, a Coulter counter, device for determining rate of sedimentation, or a mechanical screening device.

56. The process of claim 49, wherein the monitoring in step (h) occurs online.
57. The process of claim 48, wherein the fourth median particle diameter is at least about 100 microns.
58. The process of claim 57, wherein the fourth median particle diameter is at least about 120 microns.
59. The process of claim 58, wherein the fourth median particle diameter is at least about 150 microns.
60. The process of claim 57, wherein the third median particle diameter is less than 120 microns.
61. The process of claim 60, wherein the third median particle diameter is no greater than about 100 microns.
62. The process of claim 61, wherein the third median particle diameter is no greater than about 80 microns.
63. The process of claim 48, wherein the third median particle diameter is less than about 120 microns.
64. The process of claim 63, wherein the third median particle diameter is no greater than about 100 microns.
65. The process of claim 64, wherein the third median particle diameter is no greater than about 80 microns.
66. The process of claim 48, wherein the first median particle diameter is from about 60 to about 120 microns.

67. The process of claim 66, wherein the first median particle diameter is from about 65 to about 100 microns.
68. The process of claim 67, wherein the first median particle diameter is from about 65 to about 85 microns.
69. The process of claim 48, wherein the first plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.
70. The process of claim 48, wherein the separation zone is disposed within a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
71. The process of claim 70, wherein the separation unit comprises a counter-flow cyclone separator.
72. The process of claim 71, wherein the counter-flow cyclone separator is tunable.
73. The process of claim 48, wherein step (f) comprises contacting the portion of the second plurality of catalyst particles with a turbulizing stream under conditions effective to form the small catalyst stream and the large catalyst stream.
74. A process for selectively removing small catalyst particles from a reaction system, wherein the reaction system comprises a reaction zone, a disengaging zone, optionally a catalyst regenerator, optionally a catalyst

cooler and optionally a catalyst stripper, the process comprising the steps of:

- (a) feeding a plurality of catalyst particles into the reaction zone;
- (b) contacting the plurality of catalyst particles with a feedstock in the reaction zone under conditions effective to convert at least a portion of the feedstock to product;
- (c) directing a portion of the plurality of catalyst particles from the reaction system to a separation unit, wherein the portion of the plurality of catalyst particles has a first median particle diameter;
- (d) separating the portion of the plurality of catalyst particles in the separation unit into a small catalyst stream and a large catalyst stream, wherein the small catalyst stream has a second median particle diameter, and the large catalyst stream has a third median particle diameter greater than the first median particle diameter; and
- (e) directing at least a portion of the large catalyst stream to the reaction system.

- 75. The process of claim 74, wherein the second median particle diameter is less than the first median particle diameter.
- 76. The process of claim 75, wherein the feedstock comprises an oxygenate and the product comprises light olefins.
- 77. The process of claim 76, wherein the plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.

78. The process of claim 76, wherein the separation unit is selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
79. The process of claim 78, wherein the separation unit comprises a counter-flow cyclone separator.
80. The process of claim 79, wherein the counter-flow cyclone separator is tunable.
81. The process of claim 76, wherein step (d) comprises contacting the portion of the plurality of catalyst particles with a turbulizing stream under conditions effective to form the small catalyst stream and the large catalyst stream.
82. A process for maintaining a catalyst particle size distribution in a reaction system, wherein the process comprises the steps of:
- (a) directing a first plurality of catalyst particles having a first median particle diameter from the reaction system to a first separation zone;
  - (b) separating the first plurality of catalyst particles into a first small catalyst stream and a first large catalyst stream, wherein the first small catalyst stream has a second median particle diameter less than the first median particle diameter, and wherein the first large catalyst stream has a third median particle diameter greater than the first median particle diameter;
  - (c) separating at least a portion of the first small catalyst stream into a second small catalyst stream and a second large catalyst stream, wherein the second small catalyst stream has a fourth median particle diameter less than the second median particle diameter, and wherein the second large catalyst stream has a fifth median particle diameter greater than the second median particle diameter; and

- (d) directing at least a portion of the second large catalyst stream to the reaction system.
83. The process of claim 82, wherein the feedstock comprises an oxygenate and the product comprises light olefins.
84. The process of claim 83, wherein the first plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.
85. The process of claim 83, wherein step (b) occurs in a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
86. The process of claim 85, wherein the separation unit comprises a counter-flow cyclone separator.
87. The process of claim 86, wherein the counter-flow cyclone separator is tunable.
88. The process of claim 83, wherein step (c) occurs in a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
89. The process of claim 88, wherein the separation unit comprises a counter-flow cyclone separator.
90. The process of claim 89, wherein the counter-flow cyclone separator is tunable.

91. The process of claim 83, wherein step (b) comprises contacting the first plurality of catalyst particles with a turbulizing stream under conditions effective to form the first small catalyst stream and the first catalyst stream.
92. The process of claim 83, wherein step (c) comprises contacting the at least a portion of the first small catalyst stream with a turbulizing stream under conditions effective to form the second small catalyst stream and the second large catalyst stream.
93. A process for maintaining a catalyst particle size distribution in a reaction system, wherein the process comprises the steps of:
- (a) directing a first plurality of catalyst particles having a first median particle diameter from the reaction system to a first separation zone;
  - (b) separating the first plurality of catalyst particles into a first small catalyst stream and a first large catalyst stream, wherein the first small catalyst stream has a second median particle diameter less than the first median particle diameter, and wherein the first large catalyst stream has a third median particle diameter greater than the first median particle diameter;
  - (c) separating at least a portion of the first large catalyst stream into a second small catalyst stream and a second large catalyst stream, wherein the second small catalyst stream has a fourth median particle diameter less than the third median particle diameter, and wherein the second large catalyst stream has a fifth median particle diameter greater than the third median particle diameter; and
  - (d) directing at least a portion of the second small catalyst stream to the reaction system.
94. The process of claim 93, wherein the feedstock comprises an oxygenate and the product comprises light olefins.

95. The process of claim 94, wherein the first plurality of catalyst particles comprises a molecular sieve selected from the group consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, AEI/CHA intergrowths, metal containing forms thereof, intergrown forms thereof, and mixtures thereof.
96. The process of claim 94, wherein step (b) occurs in a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
97. The process of claim 96, wherein the separation unit comprises a counter-flow cyclone separator.
98. The process of claim 97, wherein the counter-flow cyclone separator is tunable.
99. The process of claim 94, wherein step (c) occurs in a separation unit selected from the group consisting of: a cyclone separator, a settling vessel, a screen and an air classifier.
100. The process of claim 99, wherein the separation unit comprises a counter-flow cyclone separator.
101. The process of claim 100, wherein the counter-flow cyclone separator is tunable.
102. The process of claim 94, wherein step (b) comprises contacting the first plurality of catalyst particles with a turbulizing stream under conditions effective to form the first small catalyst stream and the first large catalyst stream.

103. The process of claim 94, wherein step (c) comprises contacting the at least a portion of the first large catalyst stream with a turbulizing stream under conditions effective to form the second small catalyst stream and the second large catalyst stream.